

# Appendix I

## Karst And Caves

### Introduction

The management of karst resources and the associated caves is new in Southeast Alaska; this appendix was written to provide more background on these resources. It also contains technical definitions and some specific “how to’s,” such as how to maintain records on caves, which are inappropriate in the Forest-wide Standards & Guidelines. The appendix contains three parts: Characterization of the Karst Landscape, Karst Resources, and Cave Resources Management.

# Characterization of the Karst Landscape, Basis for an Ecologically-Based Management Strategy

## Introduction

The Tongass National Forest contains the largest concentration of dissolution caves known in the State of Alaska. The Forest also contains world-class surface or epikarst features particularly in the alpine and sub-alpine zones (Aley et al., 1993). The caves and epikarst features result from chemical weathering of limestone and marble bedrock. The karst and cave features and associated resources are a recently discovered and recognized attribute of the lands within Southeast Alaska and have been found to be of national and international significance for a wide variety of reasons, including their intensity and diversity of development, the biological, mineralogical, cultural, and paleontological components, and recreational values (Aley et al., 1993).

The Federal Cave Resources Protection Act (FCRPA) is the primary Federal law affecting caves. It requires protection of caves on Federal lands. A cave must possess one or more of the criteria outlined in 36 CFR Part 290.3(c) or (d) and be designated as significant as outlined in 36 CFR Part 290.3(e).

The intent of FCRPA is to protect cave resources not karst resources; however, caves and their associated resources are an integral part of the karst landscape. Therefore, the karst landscapes should be managed as an ecological unit to protect cave resources (Baichtal, 1993e, 1995).

Lands underlain by carbonate rocks in high rainfall zones of Southeast Alaska are usually karst landscapes. The karst landscapes result from the chemical weathering of the almost pure calcium carbonates, acidic peatlands adjacent to the karst lands, and highly fractured bedrock.

Karst lands add a vertical, underground dimension to land use planning. Karst landscapes function differently than other ecosystems on the Forest. Subsurface drainage networks generally operate independently of, and with more complexity than, the surface drainage systems above (Aley and Aley, 1993; Huntoon, 1992a). The watershed characteristics of the surface may have little or no relationship to the subsurface karst drainage system. On karst lands, the many solution-widened fissures at the surface become injection points into a more complex subsurface drainage system. These fissures rapidly move water and sediment delivered from surface sources vertically downward into the underground lateral systems. Thus, sediment and water transported from roads and disturbed lands may emerge unexpectedly at one or more distant springs including across surface watershed boundaries.

A large portion of a karst system's vulnerability to management disturbance is the system's openness. The degree to which the surface is connected to the karst system conduits at depth relates directly to the effect of any planned land use. A high density of solution and collapse features indicates the presence of well-developed underground systems. The presence of a single sinkhole demonstrates a direct surface/subsurface connection, even if the sinkhole intermittently retains water.

Sediment transport mechanisms are different between karst and non-karst landforms. A particle of soil in non-karst lands is transported by gravity, landslides, and/or surface water flow, sometimes over great distances into a watercourse, to become sediment. Atop a karst landform, depending on the openness of the karst system, a soil particle only needs to be transported laterally a few inches or feet before it can be washed vertically through the surface or epikarst into the karst conduits at depth.

## Karst Management Goals

This overview is intended to describe to the reader the current understanding of the function and biological significance of the karst landscapes in Southeast Alaska. It is these characteristics and our current understanding of the karst landscape on which the proposed karst management strategy is based. The proposed karst management strategy is designed to assess a karst resource's vulnerability or sensitivity to a

proposed land use. This strategy strives to maintain the natural karst processes and the productivity of the karst landscape, while providing for other appropriate land uses.

### The Karst Landscape

In Southeast Alaska, the karst landscape can be characterized as an ecological unit found atop carbonate bedrock on which karst features have developed as the result of differential solution by acid groundwater. These acidic groundwaters are a direct product of abundant precipitation and rapid passage of groundwater through the organic-rich forest soil. Recharge areas may be on carbonate or adjacent non-carbonate substrate. A few of the characteristics of this ecological unit include: mature, well-developed spruce and hemlock forests along valley floors and lower slopes, increased productivity for plant and animal communities, extremely productive aquatic communities, well-developed subsurface drainage, and the underlying unique cave resources. The basic principals of karst development and cave formation are documented in Ford and Williams (1994); White (1988); and, White and White (1989). The rate and processes controlling the aerial extent of karst landscape and cave development along the north pacific coast under the cool, moist, heavily forested conditions are not fully understood. Extensive research is needed to fully understand and describe the characteristics of this ecosystem. The following description of the karst landscape discusses its geologic and hydrologic characteristics, biologic characteristics, and natural history.

### Geologic and Hydrogeologic Characteristics

Karst landscape development in Southeast Alaska appears to be controlled by the purity of the calcium carbonate bedrock, the structure of the bedrock (i.e., faulting, fractures, and bedding), occurrence of igneous intrusions, tectonism, proximity of the carbonates to peatlands and other forest vegetation, the development of surface or epikarst, glacial history, precipitation, and temperature.

Karst existed on Prince of Wales Island long before the latest glacial advance. Recent phreatic passages into two pre-Latest Wisconsinan caves (approx. 30,000 ybp) have dissolved through Tertiary paleokarst breccias (Aley et al., 1993). Older passages have been plugged by debris from past glacial episodes. One small cave has yielded a marmot tooth which has been dated to greater than 44,500 years (Baichtal, personal communication). Most caves predate the most recent glaciation based upon the presence of glacial clays, glacial sediments, wood, Pleistocene vertebrate remains, and possibly even ancient ice. Similar features are being found during field reconnaissance on Kuiu and Chichagof Islands, and on the islands seaward of Prince of Wales Island. Such evidence clearly suggests that glaciation modified a pre-existing karst landscape, collapsing some passages and systems, gouging into others, and filling some with sediments. The epikarst, which is exceptionally well developed in higher elevations, has been removed in places at lower elevations by the most recent glaciation. Where low-elevation epikarst is present, primarily on the outer coast of islands seaward of Prince of Wales, vegetation has re-established itself and a forested epikarst developed. Where impermeable compacted glacial till and marine silts are deposited on the karst terrain, and poorly drained lithologies adjacent to karst terrain, peatlands are commonly developed. Many of the glacial deposits overlying karst terrain have filled in and modified collapsed karst features. With the development of the forested epikarst and peatlands, and the entrance of associated acidic waters into underground tributaries, a system of enlarged vadose caves and vertical shafts has developed (Baichtal, 1993a).

The rocks most susceptible to karst development are those which are greater than 70 percent calcium carbonate ( $\text{CaCO}_3$ ). Well developed karst and cave systems require that the bedrock be 90 percent calcium carbonate or better. Chemical analysis of 67 limestone and marble samples collected from the northern half of Prince of Wales and surrounding islands showed the range of calcium carbonate varied from 91.47 to 99.46 percent. The samples averaged 97.65 percent  $\text{CaCO}_3$  (Mass et al. 1992).

These very pure carbonate rocks have had a long and tortured history. They originated as marine reef and lagoonal deposits near the equator during Silurian time, some 438 to 408 million years ago (Soja, 1990). These deposits were rafted atop spreading oceanic plates until they docked on the ancient shores of

## Karst & Caves

Southeast Alaska. These rocks are part of what is now recognized as the Alexander terrane, one of five sub-continental blocks of rock which have combined to form the Ketchikan Area. The oblique collision of the Alexander terrane with North America resulted in the rocks being compressed from east to west and smeared northward along the coast. The Alexander terrane was spectacularly fractured and then fragmented at all scales as it was rifted apart and smeared northward along the Alaskan coast. This smearing occurred along large, northwest-southeast trending, strike-slip faults. Second order intersecting, north trending strike-slip faults allowed the terranes to break into huge blocks. What makes the picture more interesting is that the granite blocks bounded by the large faults are themselves broken into smaller blocks by smaller faults which mimic their large counterparts. This same fault pattern can be seen from terrane boundaries to the outcrop and hand specimen scale. The fractures serve two very important functions in the karsts associated with the Alexander Terrane. First, the intra-island and mountain-block scale faults commonly define karst system boundaries. Secondly, cave passages, chains of sinkholes, and many of the other karst features are localized along sets of small to intermediate scale faults. Epikarst development is largely a function of these fractures and faults (Aley et al., 1993; Coney et al, 1980; Brown and Yorath, 1989; Brew et al., 1992a and b; Gehrels and Berg, 1992).

Epikarst is exceptionally well developed throughout the karst areas. The alpine epikarst is characterized by deep shafts, crevasse-like dissolved fissures, eroded dissolution rills of all sizes, and spires and spikes of limestone. In the sub-alpine, the epikarst has virtually the same characteristics found in the bare alpine settings, except it is vegetated. Typical thickness of the epikarst zone ranges from more than 100 feet in the alpine zone to less than 5 feet along the coast and lower elevations. The epikarst thickness appears to be more a function of glacial history than altitude. The epikarst is extremely important in moving water, nutrients, organic matter, and soil from the land surface and from the rooting zone into the subsurface where these materials can move laterally to seeps and springs or to vertical collector structures which channel them downward into cave networks (Aley et al. 1993).

Peatlands form atop poorly drained non-carbonate rocks and impermeable compact glacial tills and marine silts that overlie carbonates. Surface waters originating from these poorly drained areas seldom flow more than a few yards onto carbonate substrate before diving below the ground, down vertical shafts or into cave entrances. The highly acidic waters from the peatlands accelerate cave and karst development. pH levels of waters flowing from these Sphagnum-dominated wetlands can be as low as 2.4 (Aley et al., 1993). Waters flowing from the cave systems that accept these waters commonly show a pH range of 7.5 to 9.0. The buffering capabilities of the pure carbonates is evident.

Most of the caves studied so far are hydrologically active. Those that carry streams are subject to extreme variations in flows. Rainfall in the areas dominated by karst terrain varies greatly, ranging from annual average precipitation of 60 to more than 250 inches per year. The largest floods occur when heavy rains fall on wet snow packs. These cave systems can best be described as very dynamic. Limited dye tracing work on Prince of Wales Island has demonstrated that karst groundwater systems routinely transport water for several thousands of feet to receiving caves, springs, and surface streams (Aley et al., 1993). The limited specific conductance information gathered to date from this same area suggests that values from karst systems in southeast Alaska are about half the mean values typically encountered in most other North American karst areas. However, karst areas in Southeast Alaska yield annual runoff which is typically on the order of 8 to 16 times greater than that found in other American karsts. The net effect is that solution of soluble bedrock occurs on the order of at least 4 to 8 times faster in Southeast Alaska (Aley et al., 1993).

Hydrologic models currently used for estimating the cumulative effects of proposed surface management activities are not designed to model the effects of timber harvest on the karst landscapes. Evidence suggests that timber harvest increases available surface waters, thereby increasing sediment and debris transport capabilities and flooding passages which have not flooded for centuries. Observations in some caves suggest that passages which now flood result in fragile ceiling formations becoming tannin-stained and showing signs of dissolution. Many cave entrances are infilled and/or blocked by logging slash, sediment, and debris. Runoff generated from road surfaces commonly is diverted into karst features. It is not known what cumulative effects past timber harvest has had on the epikarst landscape (Baichtal, 1993c).

### Biologic Characteristics

Only limited information is available on the importance of the karst landscape to plant and animal life in coastal Alaska. The following characterizes what is known about the vegetation/forest, wildlife, and fisheries components of the karst landscape:

**Vegetation/Forest.** There is a definite tie between the karst landscape and the productivity of the spruce and hemlock forests found there. The major contributors are believed to be the nutrient rich soils, well developed subsurface drainage, and dissected bedrock surface which allows the tree roots to hold fast and become somewhat more windfirm. The old growth on the karst provides a well structured, multi-layered canopy resulting in important winter habitat. The structure of the forest provides many forbs and shrubs for wildlife. It is possible that the available forage contains, at a minimum, higher calcium levels allowing for better bone, muscle, and antler development. The combination of quality forest structure and abundant nutritional browse could make the karst landscape exceedingly crucial habitat (Gustafson, 1993).

One way of demonstrating the productivity of the karst area is to compare timber volume differences between karst and non-karst areas. Exceptionally dense stands of very large diameter spruce and hemlock at lower elevations are characteristic of many karst landscapes. For example, the Labourchere Bay Final Karst Vulnerability Assessment Report (Labourchere Bay, 1994) on north Prince of Wales Island indicates 74% of volume class 7 occurring on karst. Past timber harvest on the karst landscapes has been disproportionately high most likely due to the high percentage of very large, dense forest stands. For instance, in the Central Prince of Wales FEIS analysis, 66 percent of the commercial forest land on known karst has been harvested while only 33 percent of non-karst areas have been cut (Baichtal, 1993c). It has been estimated that in some areas 70 to 80 percent of the commercial forest land within specific karst blocks on the Ketchikan Area has been harvested (Streveler and Brakel, 1993; Baichtal, 1993d). Recent analysis of the karstlands less than 1,400 feet in elevation and on slopes less than 60% (27 degrees) on the Thorne Bay Ranger District indicates that 50% of those acres have been harvested.

On karst landscapes worldwide, timber harvest has led to serious, often long-term declines in soil depth and fertility, in some cases culminating in permanent deforestation (Harding and Ford, 1993; Huntoon, 1992 a,b; Kiernan, 1993). Trees growing on karst generally have roots extending down into the dissolved cracks in the bedrock. These roots act to pump water and nutrients back up into the forest canopy. Much of the site productivity is tied up in this nutrient cycle and in the forest canopy. When trees are harvested this nutrient cycle is broken. Soils tend to be thin, residual soils on these karst areas. The greater the development of the epikarst, the greater the surface/sub-surface connection. The greater the epikarst development, the easier nutrients and soil can be transported vertically beyond the rooting depth of vegetation and into the conduit systems of the karst drainage. Vertical migration of nutrients and soil becomes possible in areas of heavy rainfall and well developed sub-surface drainage once the forest canopy is removed (Harding and Ford, 1993; Gains, 1993; Lichon, 1993). Karst systems are productive, but fragile (Huntoon, 1992 a and b; Streveler and Brakel, 1993).

Field observations and aerial photo interpretations show strong evidence of greatly increased surface runoff on karst areas after harvest. This increases sediment, nutrient, and debris transport capability of these systems. Transport capability increases both vertically and laterally. Current harvesting techniques leave the slash within the unit, which helps to protect the shallow fragile soils from erosion and drying. Timber regeneration information from the Ketchikan Area, taken on low-elevation flat-topography karst areas, indicates few regeneration problems. A considerable percentage of the easily accessible low-level karst areas within the Area have been harvested. Timber harvest is now moving onto steeper, higher elevation karst areas which are characterized by shallower, better-drained soils. Observations suggest that with harvest atop these soils, much of the soil may be removed if adequate log suspension is not achieved. Often, only a thin organic mat covers the karst. The exceedingly shallow soils become excessively dry once the protective forest canopy is removed. The high rainfall of the area can rapidly move these fragile soils into the well developed epikarst. Observations suggest that these steeper, higher elevation karst areas show less than desirable regeneration or remain as bare rock slopes within harvested units.

## Karst & Caves

**Wildlife.** Many wildlife species find the surface karst features and the stable environment and shelter provided within the caves to be valuable habitat (Baichtal, J.F., 1993b). Caves have been used as natal den sites for otters, and as resting and denning sites for deer, bear, wolves, and small furbearers. Deer are known to rest around cave entrances both in summer, when the air coming from the caves is cooler and in winter when the cave entrance environment is warmer than elsewhere.

Cave systems are known to provide critical roosting and hibernating habitat for bats (Parker, D.I., 1993). The stable environment within caves can provide roosting habitat both in summer and winter. Bats select cave sites because they fulfill very specific requirements involving cave structure, air circulation patterns, temperature profiles, humidity, and location relative to feeding sites (Hill and Smith, 1992).

Preliminary surveys in southeast Alaska show some bat usage in many of the caves inventoried. Bats have been found within a few caves once temperatures drop below freezing. Roost sites are beyond where freezing air temperatures penetrate from the cave entrance. Southeast Alaska caves appear to be most important to bats during periods of winter torpor. No use of caves by bats as summer roosts or maternity colonies has been noted yet. Much more work remains before good understanding of year-around importance of caves bats is understood. Three species of bats have been reported from caves in the Ketchikan Area: *Myotis lucifugus*, *M. californicus*, and a possible *Lasionycteris noctivagans*. During the summer of 1993 the first ever specimen of *Myotis volans* has been collected from Prince of Wales Island (D. Parker, 1993). In December 1991, the first ever recorded hibernating bat in Alaska was described and photographed from within El Capitan Cave. The *Myotis californicus* collected in El Capitan cave in February of 1992 was the first live record of that species in Alaska (Parker and Cook, 1993).

Cave systems provide habitat for many invertebrate organisms. Preliminary studies conducted during July 1992 identified 77 species from collections made within several caves. Taxonomic identification of these species must be done before further biological correlations or associations can be made. One amphipod has been identified as *Cratigonyx obliquus-richmondensis*, the first ever record of this amphipod's occurrence in a cave in all of northwestern North America (Carlson, 1993a). Field work continued during the 1993 and 1994 field seasons, with collections made from a number of caves. A troglodytic *Stygobromus* amphipod was collected on Heceta Island to the west of Prince of Wales Island. This species is morphologically identical with *Stygobromus quatsinensis* from two caves on Vancouver Island, British Columbia, Canada (Holsinger, 1987, 1993). This discovery is possibly a high-latitude world-record for a cave adapted species (Aley et al., 1993). Similar *Stygobromus* species were discovered in caves and karst springs on the western shore of Dall Island during the summer of 1993 (Carlson, 1993b).

Some bird species including dippers, thrushes, and swallows, have been known to use cave entrances for nesting and feeding. Rookeries for seabirds including cormorants and pigeon guillemots, and murres and puffins on Coronation Island have been found in some littoral caves (Baichtal, 1993b).

**Fisheries.** The karst landscape influences productivity of its aquatic habitats in several aspects. The geochemistry associated with karst development contributes to productivity in aquatic environments through its carbonate buffering capacity and carbon input from dissolved limestone bedrock. This has significant downstream effects on the aquatic food chain and biotic community. Preliminary studies (Swanston, personal communication) suggest that aquatic habitats associated with karst landscapes may be eight to ten times more productive than adjacent non-karst dominated aquatic habitats. The karst dominated aquatic habitats support a higher abundance, distribution, density, and variety of invertebrate species than the non-carbonate based systems, have higher growth rates for smolts and resident fish, reflect less variable water temperatures and flow regimes, and contain unique habitat affecting species distribution, abundance, and adaptations (Wissmar et al., in press; Bryant et al., in press; Swanston, personal communication, 1993). It is believed that karst waters have the following connection to fisheries:

1. The carbonates have important buffering effects. Very acidic waters flow from the peatlands (pH 2.4 to 5.8) into karst systems, emerging at a slightly basic pH of 7.5 to 9.
2. Resident time for groundwater in the karst systems results in cool, even temperature water. Flow rates through caves are relatively consistent. The storage capability of the karst systems



- results in lower peak flows and higher low flows. This helps to moderate the effects of storm events on resurgence streams. The systems do remain flashy though.
3. The cave systems filter out some debris and sediments, although they do not filter out chemical impurities or microorganisms.
  4. Smolts and resident trout use the cave systems for protection from predation, for shade, and for a feeding area, since many insects utilize the photic zone of the cave system for breeding and shelter. Adult salmon have been seen spawning through some cave systems, and evidence of salmon spawning in the caves has been found. Salmon are reported to spawn within one river cave system on Chichagof Island.
  5. Karst streams have much greater and more diverse aquatic insect populations, both within the caves and in the streams. There also seems to be greater moss and algae growth within the carbonate dominated systems, most likely reflective of nutrient availability (Swanston, 1993).

### Natural History, and Paleontological and Cultural Resources.

The potential cultural and paleontological significance of the caves and karst landscape is high. The Pleistocene paleontology of the area is primarily known from cave and rock shelter deposits, which are often intimately related to archaeological sites. The cool, stable, basic environments in the caves result in exceptionally good preservation of bone and organic materials (Aley et al., 1993). Recent paleontological work in caves on Prince of Wales and surrounding islands, along with botanical surveys of alpine areas and genetic studies on chum salmon populations, argue for a well developed coastal refugium along the western coast of southern southeast Alaska. The evidence sheds new light on problems of glacial chronology, climatic change, biogeography, and archaeology along the western margin of North America (Autrey and Baichtal 1992; Heaton and Grady, 1992; Dixon et al., 1992).

To date, significant archaeological and paleontological materials have been discovered in at least thirty caves and rock shelters on the Ketchikan Area (R. Carlson, 1993). During the summers of 1993 and 1994, at least three new bone deposits were located during inventory of caves.

Recently, four black bears (*Ursus americanus*), one of which dates to approximately 11,565 years before present (B. P.) and thirteen grizzly or brown bears (*Ursus arctos*), now extinct on Prince of Wales Island, ranging in age from 35,363 to 7,205 B.P. have been discovered. A possible black bear tibia has been dated to greater than 39,100 B.P. Natal otter (*Lutra canadensis*) dens dating to 8035 B.P. have also been discovered and described (Baichtal, 1993b). Early humans were exploring some caves during the middle Holocene. Evidence of human habitation, the oldest dating to nearly 4,500 B.P., has been discovered in several caves on Prince of Wales and seaward islands. The remains of red fox (*Vulpus vulpes*), caribou (*Rangifer tarandus*), and marmot (*Marmota* sp.), now extinct on the islands, have been recovered (Heaton 1994, 1995a & b). The marmot was dated to over 44,500 years B.P. Botanical studies on Dall and Prince of Wales islands have described plant populations which suggest ancestry from local remnant populations that escaped glaciation (Hulten, 1968; Muller, 1991). Recent research concerned with chum salmon populations from the Queen Charlotte Islands and Southeast Alaska has shown that the greatest genetic variation exists in the fish along the western coastlines of Queen Charlotte and Prince of Wales Islands (Kondzella, 1993). These significant genetic variations suggest longer habitation of streams in these areas, and therefore the possibility of coastal refugia. The occurrence of the *Stygobromus* species on Heceta, and Dall and Coronation Islands also supports the refugia theory. The apparent lack of troglodytes on Prince of Wales Island appears to be correlated with the glacial history of the region (Aley et al., 1993). This new information, combined with limited data on raised marine beaches in the area, strengthens the argument for a coastal refugium, along which Pleistocene mammals and humans may have migrated.

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### Karst Resources

#### Useful Definitions

Due to the uniqueness of the karst landscapes, definition of several terms is needed for a better understanding of the resource. The following terms are used throughout this appendix:

1. **"Karst"** is a type of topography which develops as the result of the dissolution of soluble rocks, in this case limestones and marbles. Dissolution of the subsurface strata produces a landscape that is characterized by well-developed subsurface drainage, collapse features such as sinkholes, dry valleys, vertical shafts, caves, and fluted rock surfaces (epikarst).
2. **"Karst Landscape"**, in southeastern Alaska, can be characterized as a three-dimensional ecological unit found atop and within carbonate bedrock in which karst has developed and including the recharge areas on adjacent non-carbonate substrate. A few of the characteristics of this ecological unit include: mature, well-developed spruce and hemlock forests along the valley floors and lower slopes, increased productivity for plant and animal communities, extremely productive aquatic communities, well-developed subsurface drainage, and the underlying unique cave resources.
3. **"Karst Resources"** refer to all components of the karst system. These include both the physical and biological components of the karst landscape.
4. **"Epikarst"** is the surface of the karst. It is an intensely dissolved veneer consisting of an intricate network of intersecting dissolution-widened fissures, cavities, and tubes. It is this network of intersecting fissures which collect and transport surface waters and nutrients vertically to the underlying karst conduits.
5. **"Cave"** is legally defined under federal law as: "... any naturally occurring void, cavity, recess, or system of interconnected passages beneath the surface of the earth or within a cliff or ledge and which is large enough to permit a[n] person to enter, whether the entrance is excavated or naturally formed. Such a term shall include any natural pit, sinkhole, or other opening which is an extension of a cave entrance or which is an integral part of the cave (36 CFR 261.2)". Speleologists use "cave" to refer to all parts, regardless of size, of an underground system that links openings and chambers and that may connect the system to the surface. The most common type of cave is formed in carbonates by dissolution. Included in the term "caves" are tree molds and lava tubes associated with lava flows, erosional caves, boulder caves, glacier caves, and littoral caves, as well as those formed by dissolution of bedrock.
6. **"Cave Coordinator"**. An individual with responsibility for managing cave resources. The Forest Coordinator, has forest oversight responsibilities, while the District Cave Coordinator has on-the-ground responsibilities for cave resource management.
7. **"Cave Entry Permit"**. A permit issued to allow entry into a closed cave. Usually the permit will allow entry of a maximum of six persons at one time.
8. **"FCRPA"**. Federal Cave Resource Protection Act of 1988. This law establishes a Federal mandate to identify, protect, and manage caves on public lands administered by the departments of Agriculture and Interior. It may be referred to as the "Act".
9. **"Cave Resources"** includes any material or substance occurring in caves including, but not limited to, biological, cultural, mineralogical, paleontological, geological, hydrological, and recreational resources.
10. **"Significant Cave"** means a cave located on Federal lands that has been determined to meet the criteria in 36 CFR 290.3(c) or (d) and has been designated in accordance with 36 CFR 290.3(e).
11. **"Sinkhole"** or **"Doline"** (used interchangeably) are terms used to describe relatively shallow, bowl- or funnel-shaped depressions ranging in diameter from a few feet to more than 3,000 feet. These depressions are generally formed by dissolution of and subsequent settlement of bedrock to form a depression or collapse feature.
12. **"Speleothem"** means any natural mineral formation or deposit occurring in a cave or lava tube, including but not limited to any stalactite, stalagmite, helictite, cave coral, flowstone, soda straw, drapery, rimstone, or formation of clay, sand, or mud.

13. **"Speleogen"** refers to relief features on the walls, ceiling, and/or floor of any solution cave or lava tube. Speleogens are part of the surrounding bedrock. They include but are not limited to anastomoses, scallops, meander niches, petromorphs, and rock pendants in solution caves and similar features unique to volcanic caves.
14. **"Vulnerability Mapping"** or **"Karst Vulnerability"** is a management tool used to assess the susceptibility or sensitivity of the karst resources to any proposed land use. This type of approach is similar to "hazard area mapping" or "risk assessment". The thesis of this approach recognizes that not all karst development and associated resources are equal. Vulnerability mapping utilizes the fact that some parts of a karst landscape are more sensitive than others to planned land uses.

### Karst Landscape Assessment

Karstlands impose land management challenges not encountered in non-karst areas because this three dimensional landform functions differently than do other landforms. Evaluate karst resources as to their vulnerability to land uses affecting karst systems. Vulnerability mapping recognizes that some parts of the karst landscape are more sensitive than others to surface activities and groundwater contamination. These differences in vulnerability may be a function of the extent of karst development, the openness of the karst systems, and the sensitivity of other resources that benefit from karst groundwater systems. Assess karst resource vulnerability for both large geographic areas and site-specific projects. Complete vulnerability assessments of large geographic areas for any karst area where land-disturbing activities are planned. Conduct site-specific vulnerability mapping on a project by project basis or as field verification of the larger scale karst vulnerability assessment. Karst lands will be classified as being of low, moderate, and high vulnerability. This is a four-step process:

1. **Identify Potential Karst Lands.** Identify those lands underlain by carbonate rocks. As a practical matter, all lands underlain by carbonate rocks within the Forest should be considered a karst landscape.
2. **Inventory Karst Resources.** At the beginning of any land-disturbing project planning effort, determine the project's proximity to or position on a karst landscape. If it is determined that karst occurs in the project area, require a complete inventory. Assess the degree of karst development. If karst is present, as a minimum the following information will be recorded:
  - a. The degree to which karst has developed including the degree of epikarst development, the presence of caves, the presence of insurgences and resurgences, sinkholes, collapse channels, and other karst features.
  - b. When caves are identified, they will be surveyed and inventoried in accordance with cave management guidelines. To maintain continuity of inventory reports and cave maps, specifications will be addressed prior to commencement of inventory work. During inventory work caving ethics and protection of cave resources will be stressed.
  - c. The relative position of karst features both within and adjacent to the planned activity.
  - d. The slope of the land and the depth and nature of soil atop the karst.
  - e. The presence of any Class I or Class II streams being significantly contributed to from the karst hydrologic systems. It is only intended that streams which have had sufficient residence time or contact with the carbonate bedrock which show appreciable geochemically changed be considered. Temperatures less than 5 degrees C., pH ranging from 7.5 - 9.0, and specific conductance greater than 120 would be an indication of the highest value karst waters. It should be recognized that some normally dry drainage channels in a karst landscape will periodically carry large flows when the capacity of underlying conduits is exceeded during high flow events.
  - f. Sensitive habitats and features that might be adversely affected by land use changes in the area being investigated. These habitats and features must specifically include, among other things, streams important to fisheries and streams or springs used as domestic water supplies, habitats which support cave adapted organisms, and critical bat winter habitat and/or roosts. When considering karst streams and springs, the inventory work must recognize that many sensitive

## Karst & Caves

habitats and features are likely to be located appreciable distances away from points where waters enter the karst groundwater system.

- The results of the survey shall be documented and digitized onto the Region's GIS data base. The area's geology, location of karst features and caves, and the vulnerability of specific karst areas shall be recorded.
- Delineate Karst Hydrologic System and Catchment Area.** Define, to the extent feasible, the karst hydrologic system and the recharge area watershed or catchment area for each karst system. The character of the catchment area, i.e., the area, slope gradient, vegetation, water quality, soils, etc. controls the nature of the receiving karst system and defines the volume of runoff available for infiltration into the system. Recharge area delineation is a crucial component of vulnerability mapping; you must know where the water comes from and resurges to credibly assess and characterize possible impacts. At a minimum, the following information will be recorded:

  - During the inventory phase, record the location of all resurgence, insurgence, losing streams, sinkholes or other features appropriate for injection of tracing dyes. Estimate water volume entering or discharging from the groundwater system at the time of the visit. Describe prevailing weather conditions at the time of the visit.
  - Perform a sufficient number of dye traces to assess the karst hydrologic system or systems within a study area. Conditions on the Forest are such that flow direction of tracer dyes cannot always be predicted. This unpredictability reinforces the need for a thorough area search for all resurgence and accurate estimates of stream and spring flows.
  - Record the results of the dye traces, indicating the relative position of the dye injection point and the position of the resurgence or spring where the dye was recovered. Record the tracer dye's travel time and concentration, if known. Record resurgence and streams that were sampled but no dye was recovered. Document and digitize results onto the Regional GIS data base.
- Assess Vulnerability of Karst Terrain to Management Activity.** The final step is to delineate the land under investigation into various vulnerability categories. An area's vulnerability rating must be sensitive to potential surface management practices based on the extent to which epikarst has developed and the openness of the karst system. The vulnerability categories and their criteria are as follows:

  - Low Vulnerability Karstlands**

    - Classification Criteria.** Low vulnerability karstlands are those areas where resource damage threats associated with land management activities in the areas are not likely to be appreciably greater than those posed by similar activities on non-carbonate substrate. Some characteristics of these lands are:

      - Karst development is limited or has been modified by glaciation;
      - Epikarst development is relatively shallow;
      - Solutional karst features are present but not numerous;
      - Soils are primarily mineral, soil depth is shallow to deep, the soils are moderately well to well drained, parent material is the carbonate substrate, glacial till, or volcanic.
      - No caves are present;
      - There are no slopes  $\geq 72$  percent;
      - The karst hydrologic system does not contribute waters to Class I or Class II streams and/or domestic watersheds;
      - They lie within a watershed which contributes surface waters to a karst area determined to have a low vulnerability.
    - Karst Management Objectives and Appropriate Land Uses.** These are areas of low or negligible vulnerability from a karst management perspective. No special provision for the protection of karst values is considered necessary. Timber harvest and related activities could be conducted in such areas in a similar manner to those normally employed on lands underlain by non-carbonate bedrock. Partial suspension yarding may be required. No quarry shall be developed atop karst without adequate site survey and design. Quarries should be properly closed after abandonment. Recreational development would be appropriate with consideration of karst resource values.

It is possible that karst areas with high vulnerability will be found within and adjacent to areas found to be of low vulnerability. Along such boundaries or margins, guidelines outlined under "Moderate Vulnerability Karstlands" shall apply.

b. **Moderate Vulnerability Karstlands**

- i. **Classification Criteria.** Moderate vulnerability karstlands are those areas where resource damage threats associated with land management activities in the areas are appreciably greater than those posed by similar activities on low vulnerability karst lands. Some characteristics of these lands are:
  - (a) Karst systems are moderately well developed;
  - (b) Epikarst is up to eight feet in depth;
  - (c) Solutional karst features are present but not numerous;
  - (d) Soils are a mosaic of both mineral and organic. Mineral soils vary from shallow to deep, are well drained, and parent material is the carbonate substrate. Organic soils are shallow and well drained. If the soil was displaced from the bedrock, it would be retained in the adjacent solutional channels of the epikarst. The percentage of bare rock would increase but the soils would not be transported beyond the rooting depth of young conifers;
  - (e) No caves are present;
  - (f) There are no slopes  $\geq 72$  percent;
  - (g) The karst hydrologic system does not contribute waters to Class I or Class II streams and/or domestic watersheds;
  - (h) They lie within a watershed which contributes surface waters to a karst area determined to have a low vulnerability.
- ii. **Karst Management Objectives and Appropriate Land Uses.** To provide for other land uses taking into account karst management objectives. Timber harvest and related activities could be conducted in such areas under more restrictive guidelines than normally employed on lands underlain by non-carbonate bedrock. To protect the fragile soils found here, as a minimum, the yarding system selected may be required to achieve partial suspension. Longer timber harvest rotational periods may be appropriate. Reduced timber harvest unit size and a greater dispersal of harvest units may be required. Existing roads and quarries will be utilized in preference to the construction of new ones. Roads shall, to the extent feasible, avoid sinkholes and other collapse features and losing streams. Roads should not divert water to or from karst features. Measures shall be taken to reduce erosion and sediment transport from the road surface and cutslopes. Sediment traps, cut and fill slope revegetation, and road closure and revegetation may be appropriate. Because karst development is more intense here, additional design criteria may be required. Such criteria may relate to road construction methods, blasting, culvert placement and density, and sediment retention and erosion prevention. No quarry shall be developed atop karst without adequate site survey and design. Quarries should be properly closed after abandonment. Recreational development would be appropriate with consideration of the karst resource values listed above, particularly with respect to reducing disturbance of sensitive soils and use of construction methods that avoid erosion and diversion of natural and road drainage waters into karst features.

It is probable that karst areas with high vulnerability will be found within and adjacent to areas found to be of moderate vulnerability. Along such boundaries or margins the following guidelines shall apply:

- (a) No surface disturbing activity such as timber harvest, road construction, and/or quarry development shall occur within a minimum of 100 feet of the edge of a sinkhole, collapse channel, doline field, losing stream, or other collapse karst feature if groundwater dye tracing studies have indicated that such features contribute to Class I or Class II streams or a domestic water supply. If groundwater dye tracing studies have not been completed and it is suspected that the groundwaters contribute to a "significant" cave, Class I or II stream, or domestic water supply, no ground disturbing activity shall occur within 100 feet of any above mentioned karst features;



## Karst & Caves

- (b) No surface disturbing activity such as timber harvest, road construction, and/or quarry development will occur on lands that overlie a known "significant" cave or contribute waters to any known "significant" cave. Neither should these activities occur on lands that are close enough to the entrance of a significant cave to be capable of altering the microclimate of the cave's entrance and/or cave features within;
  - (c) When designing buffers to protect karst systems and their features, the buffer should be designed to be wind-firm. There is no credible standard buffer distance that will provide the assurance required to protect the systems from blowdown of the forest within a given buffer. Each buffer must be carefully designed considering wind direction patterns, blowdown history, previous adjacent harvest, topography, and stand windfirmness. Delineated lands surrounding such features and systems must be of sufficient size to insure protection even if blowdown occurs.
- c. **High Vulnerability Karstlands**
- i. **Classification Criteria.** High vulnerability karstlands are those areas where resource damage threats associated with land management activities in the areas are appreciably greater than those posed by similar activities on low or moderate vulnerability karst lands. These are the areas contributing to or overlying significant caves and areas containing a high density of karst features. Some characteristics of these lands are:
    - (a) Karst systems are extremely well developed;
    - (b) Epikarst is greater than eight feet in depth and may be open to the lateral karst conduits at depth;
    - (c) Solutional karst features are numerous;
    - (d) Soils are primarily shallow, well drained organics. Exposed bedrock areas are common to extensive. If the soil is displaced from the bedrock, it may be retained in the adjacent solutional channels of the epikarst; however, the percentage of bare rock would greatly increase and the soils most likely would be transported beyond the rooting depth of young conifers. If the karst systems are extremely well developed and open, soils may not be retained within the epikarst channels. They would be rapidly transported to the lateral karst conduits at depth;
    - (e) Caves may be present;
    - (f) Karst areas may contain slopes  $\geq 72$  percent;
    - (g) The karst hydrologic system may contribute waters to Class I or Class II streams and/or domestic watersheds;
    - (h) They lie within a watershed which contributes surface waters to a karst area determined to have a high vulnerability.

**Karst Management Objectives and Appropriate Land Uses.** These areas shall be managed to insure conservation of karst values through the implementation of a high level of protection. Timber management and related activities should be excluded from these lands. Small expanses of these areas may be crossed by roads to access areas where harvest is appropriate, i.e. low or moderate vulnerability karst lands and non-carbonate areas. This would only be allowed if no other route or option was available and karst resource values would not be compromised. No quarry development would be allowed on these lands. Limited recreational development may be appropriate. Roads across such sensitive terrain except as described above, are inappropriate. Recreational facilities and trails would have to consider karst resource values and objectives discussed above, particularly with respect to reducing disturbance of significant epikarst features and sensitive soils and use of construction methods that avoid erosion and diversion of natural drainage waters into karst features.

Karst lands found to be of unquestionably high vulnerability shall be identified and removed from the commercial forest lands suitable land base.

## Catchment Area Management

The catchment areas for karst systems, comprised of carbonate or non-carbonate substrate, are an integral portion of those system. These catchment areas must be effectively managed to protect the resource values of the karst systems into which they flow. The higher the resource values found within a particular karst block, the higher the degree of protection which is needed within a contributing catchment area. As a minimum, such things as potential for increased runoff and increased stream velocities, increased sediment transport capability, mass wasting potential of the soils within the watershed, and increased wind-throw potential should be considered when developing management strategies for these catchment areas. The vulnerability of the karst system's catchment areas should be considered equal to the highest down-gradient karst vulnerability values. As part of site-specific analysis, management strategies developed for the catchment areas should insure protection of the down-gradient karst resource values.

### **Monitoring**

A monitoring strategy should be developed and maintained to determine the effects of land uses, specifically timber harvest and road construction on the karst landscape. As a minimum, karst hydrology, soil loss, forest regeneration, sedimentation, and debris transport should be monitored.

### **Mineral Development**

The chemically pure carbonates of southeastern Alaska have long been considered for their commodity values. Values are not determined solely on chemical purity but on brightness as well. The more pure the carbonate bedrock, the more intense karst development. It is not the intent of these standards and guidelines to restrict any lands from mineral development, though that may be appropriate if a specific project or area is allocated to the "Special Interest Area" Land Use Designation. The impacts of any proposed mineral development within the karst landscape can be analyzed through the environmental analysis which is triggered once a Plan of Operation is received.

### CAVE RESOURCES MANAGEMENT

1. **Cave Inventories and Designation.** The inventory of caves is an ongoing process. The Forest will continue to aggressively pursue collection of inventory data. This will be accomplished mostly through partnerships with caving organizations. Collection of this information will be the responsibility of the Unit cave management coordinator.
  - a. Each of these caves will be assigned a unique cave inventory number, and, except in wilderness, a brass cave inventory cap will be placed at each entrance. The brass caps provide a permanent identification marker at each cave entrance and allow a distinction to be made between known and newly discovered caves.
  - b. Cave numbers will be assigned to each cave entrance. Caves with multiple entrances will bear the same number at each entrance, followed by alpha characters (A, B, C, etc.) to differentiate between individual entrances. Cave numbers are assigned by Region, Forest, and Unit, followed by consecutive numbers for each cave on the Unit. For example, the number assigned to the main entrance of El Capitan Cave (10-5-4-70-A). The key to this numerical designation is as follows:

10	=	Region 10
5	=	Tongass National Forest, Ketchikan Area (Forest 5)
4	=	Thorne Bay Ranger District (Unit 4)
70	=	Cave No. 70 on the Unit
A	=	First Entrance of El Capitan Cave.
  - c. Except in wilderness, brass cave inventory caps, stamped with the cave number, will be grouted into a drill hole at each entrance. The caps will be placed in obvious, easily found locations. Care will be taken when placing the markers to avoid locations which would unnecessarily impact the aesthetics of the cave or cause resource damage.
2. **Records.** On each management unit with caves, a file of permanent data will be maintained for each cave. This file will remain locked, with access provided on a need-to-know basis only. At a minimum, the following information will be collected and maintained for each cave:

a. Cave Name	j. Range
b. Cave Number (entrance number)	k. Section
c. Determination of Significance	l. Quadrant
d. Date Marker Cap Set	m. Cave Classification
e. Cave Length	n. Special Management Concerns
f. Latitude	o. Alternate Cave Names
g. Longitude	p. Descriptive Notes
h. Elevation	q. Cave Map
i. Township	

In addition to the above information, photographs, scientific reports, copies of newspaper clippings, or other printed materials relating to a specific cave should be included in the file.
3. **Naming of Caves.** If a new name is to be applied to a cave there are two rules which should be followed:
  - a. Never name a cave after a living person;
  - b. Never name a cave after a geographic feature which discloses the cave's location.
4. **Cave Locations.** Information concerning the location of caves will be kept confidential in accordance with provisions of the FCRPA.
  - a. Only the location of caves classified as "Directed Access" will be made available to the public;
  - b. Cave locations recorded in GIS will be placed on a separate, secure layer, and all inventory records will be maintained in a locked file. Access to these records will be permitted on a need-to-know basis only. Generalized information which does not lead to the disclosure of cave locations may be made available if it is determined that such disclosure would not

constitute a threat of theft, damage, or harm to cave resources, and is consistent with the purposes of the FCRPA, the implementation regulations, Forest Plan Standards and Guidelines, and FSM 2356.

5. **Partnerships.** Use partnership agreements or volunteers to assist with cave management. The use of volunteers is authorized by the Volunteers in the National Forest Act (16 USC 558), the Federal Cave Resources Protection Act of 1988, and a National Memorandum of Understanding between the USDA Forest Service and the National Speleological Society, dated September 30, 1988. Actively seek and participate in interagency agreements and partnerships with both Federal, State and private partners, to meet the goals of this management plan. Emphasize opportunities for cooperative bat management.
6. **Suggested Monitoring/Management for Recreational Use.** Recreational use of only a few caves in the Tongass National Forest is currently taking place. However, with increased interest in the resource and increasing population, access, and tourism, cave use and visitation is expected to increase. Recreational use monitoring of select undeveloped caves has been done elsewhere through the use of cave registers or electronic counters. It is suggested that these proven techniques be used on the Tongass. Seek assistance from the National Speleological Society in monitoring projects. Include the following monitoring and management at a minimum:
  - a. Photo monitoring of points established in sensitive caves to assess visitor impacts. Revisit these photo points periodically and take new photos from the same spots. Compare these photos to determine impacts to the cave and as a help in establishing appropriate use levels;
  - b. Development of a brochure describing the sensitivity of cave resources to disturbance, cave access policy on the Forest, and precautions explorers should follow to prevent damage to caves. Caving safety and equipment will also be included. Develop the brochure in partnership with caving organizations.
7. **Protection of Cave Entrances.** Cave entrances are both sensitive and critical to cave ecosystems. Entrances are a focus of biological activity which contributes nutrients to deep cave organisms. The moderating affect of warm moist cave air creates micro-environments in cave entrances which promote growth and occupation by unusual plants and animals. Disruption of this ecosystem by development, or heavy recreational use should be avoided. Archaeological and paleontological sites are frequently found in cave entrances, particularly beneath vertical drops. Protection of cave entrances should include the following considerations:
  - a. Recreational use, or development of cave entrances may be permitted only when it has been determined to be consistent with provisions of the Federal Cave Resources Protection Act;
  - b. When heavy use is anticipated, narrow pathways should be provided to minimize disturbance;
  - c. The building of fires in caves and cave entrances will be prohibited;
  - d. No camping in caves and cave entrances unless it is deemed necessary. Camping may be permitted when it has been determined to be consistent with protection of cave resources.
8. **Digging in Caves.**
  - a. All digging, moving of rocks, or enlargement of passages to allow exploration requires a permit. Digging should generally be minimal, and waste products disposed of, or graded in a manner specified in the digging permit. Excavations made as a part of scientific investigations will be backfilled and graded to natural contours.
  - b. Issue permits only when it has been determined that no damage to cave resources will take place;
  - c. If formerly closed passages are opened, take measures to maintain former atmospheric conditions through use of airlocks or gates.
9. **Permanent Anchors.** In vertical caves, use natural anchors for rigging ropes when possible. Chocks, cams, and slings are acceptable low impact anchoring devices. The use of permanent anchors, such as expansion bolts, will be set only when approved in advance by the Forest Service and generally not in wilderness. Acceptable reasons to set bolts would be lack of safe natural

## Karst & Caves

anchors, directing ropes to avoid loose rocks, reduce rope abrasion, or to protect fragile cave resources.

- 10. Climbing.** Climbing in caves may be allowed when needed to overcome vertical obstacles during exploration. Sport climbing may be allowed in the vicinity of cave entrances when no risk of damage to cave resources is present. Climbing must not mar, deface, or leave visible signs of activity having taken place. The use of chalk to dry climber's hands, and which leave marks on handholds, is considered a defacement and will not be permitted.

**11. Closed Caves/Cave Entry Permits.**

- a. All sensitive caves will be closed by order of the Forest Supervisor and entry allowed by permit only. A sign at the entrance of each sensitive cave will designate it as closed to visitation without a permit, and indicate the address and phone number where permit information may be obtained.
- b. Establish a carrying capacity for exploration purposes for each sensitive cave and determine allowable uses. Issue permit only for uses compatible with long-term preservation and protection of cave resources. Except in unusual circumstances, the maximum party size permitted in any sensitive cave will be six persons. Establish a maximum number of visits per month and per year. Each unit will be responsible for issuance of permits for caves under their jurisdiction.
- c. Use gates to control access to certain caves. When it is determined a gate is required, design and install the gate to allow free passage of bats, small animals, air and water into or out of the cave. Gates will be constructed using the best designs available and located for maximum wildlife acceptance.
- d. Certain caves on the Tongass National Forest provide critical winter habitat for bats. Bats have a low tolerance to disturbance. Recreational use during hibernation can result in death when disturbance results in starvation from utilization of limited fat reserves. Use seasonal closure of caves for protection of hibernating bats or bat maternity sites as appropriate. Winter closure will generally be between November 1, through April 15. Bat caves may be open to visitor use when bats are not present.
- e. Blasting and other surface management activities can result in significant disturbance of roosting and hibernating bats within the cave systems. Some birds and large mammals and furbearers utilize the caves for nesting, denning and hibernation. Seasonal closures prohibiting construction activities in some areas may be required to insure protection of these populations.

- 12. Cave Evaluation.** All caves on the Tongass National Forest will be evaluated using the following rating system. The system assigns values to various cave resources. The assigned values will be used in determining cave classification and in making determinations of cave significance as provided by the implementation regulations for the Federal Cave Resources Act of 1988. If a cave has a value of "1" or greater, in one or more categories, the cave will be considered for designation as significant using the criteria in 36 CFR 290.3(c) and (d) (FCRPA Implementation Regulations, 1994).

**a. Biological Resources**

<b>Value</b>	<b>Explanation of Value</b>
0	Biological components lacking.
1	Biological components exist but of low apparent significance.
2	Biological components present and numerous, sensitivity low.
3	Biological components present, numerous and of moderate sensitivity.
4	Biological components numerous and sensitive to disturbance.
5	Biological components very numerous and highly sensitive to disturbance. Habitat is critical to species survival. The cave contains unique species, or ones found on State or Federal sensitive, threatened, or endangered species lists.



## b. Hydrological Resources

Value	Explanation of Value
0	Hydrologic components lacking.
1	Hydrologic components present but of low importance.
2	Hydrologic components present but of low sensitivity.
3	Hydrologic components present and of moderate sensitivity.
4	Hydrologic components important and very sensitive.
5	Hydrologic components complex and highly sensitive.

## c. Heritage (cultural/historic) Resources

Value	Explanation of Value
0	Heritage resources lacking.
1	Potential for heritage resources low.
2	Potential for heritage resources moderate.
3	Heritage resources present or implicated by historic records. Site may be eligible for the National Register of Historic Places.
4	Heritage resources present and sensitive to disturbance. Site eligible for the National Register of Historic Places.
5	Heritage resources present and highly sensitive to disturbance. Site eligible for the National Register of Historic Places.

## d. Recreational Resources

Value	Explanation of Value
0	Cave lacks recreational value.
1	Recreational value low. Little or no scenic appeal.
2	Recreational value low but receiving some use. Scenic values low.
3	Recreational values, scenic values and use moderate.
4	Recreational values, scenic values and use high.
5	Recreational values, scenic values and use very high. A major cave of regional or National significance.

## e. Geologic/Mineralogic/Paleontologic Resources

Value	Explanation of Value
0	Features of significance lacking.
1	Some interesting features present.
2	Features present and resistant to disturbance.
3	Features present and of moderate sensitivity to disturbance.
4	Features numerous and of high value. Features sensitive to disturbance.
5	Features rare, valuable, numerous and/or of great sensitivity to disturbance.

## f. Educational or Scientific Resources

Value	Explanation of Value
0	Caves lacking educational or scientific value.
1	Caves with low educational or scientific value.
2	Caves with features which can be used for educational or scientific study, but are otherwise considered common to the area.
3	Caves which provide opportunity for educational or scientific study.
4	Caves providing unusual opportunity for educational or scientific use.
5	Caves with unique opportunity for interpretation and public education or scientific study.

13. **Cave Classification.** Place caves into one of the following classes based on management objectives consistent with identified cave resource values. As new caves are discovered, temporarily manage them as Class 1 until an analysis of resource values is completed.

## Karst & Caves

- a. **Class 1. Sensitive Caves.** Caves considered unsuitable for exploration by the general public either because of their pristine condition, unique resources or extreme safety hazards. They may contain resources that would be impacted by low levels of visitation. These caves are not shown on maps or discussed in publications (such as guides, brochures or magazines) intended for general public use. Develop specific management guidelines for each sensitive cave for the purpose of protecting and maintaining their resources. Close these caves by order of the Forest Supervisor, and allow entry by permit only.
  - b. **Class 2. Directed Access Caves.** Caves with directed public access and developed for public use. These caves are shown on maps or have signs directing visitor access; frequently have guided tours and artificial lighting. Regardless of the level of development, encourage public visitation. The caves may have sensitive resources that are protected.
  - c. **Class 3. Undeveloped Caves.** Caves that are undeveloped but are suitable for exploration by persons who are properly prepared. In general, these caves contain resources that resist degradation by moderate levels of recreational use. Public attention will not be directed toward these caves. They will not be shown on maps nor discussed in brochures or publications intended for general public distribution.
14. **Staffing Requirements.** It is recommended that :
  - a. A position of Forest Cave Coordinator be designated. This position would have responsibility for coordinating all cave related activities on the Forest. This position would further be responsible for maintaining inventory records of all caves on the Forest, coordinate determinations of cave significance, provide expertise to field units concerning cave management, and assure guide lines, policies, plans, and laws pertaining to caves and cave resources are followed. The position would coordinate funding requests from field units, and transmit those requests to appropriate authorities. This position may be shared with the Regional Office to provide cave management direction and assistance to other National Forests;
  - b. On field units with caves, a District Cave Coordinator should be identified. This position will assume field level responsibility for inventory, evaluation, and management of caves. District Cave Coordinators will manage local activities related to caves, including issuance of cave access permits, research permits, cave gating, record keeping, and monitoring of impacts caused by use or management activities.
15. **Prohibitions.** The following acts will be prohibited by order of the Forest Supervisor pursuant to 36 CFR Sec. 261, 262, Subpart B:
  - a. In bat caves, or caves with sensitive species (261.53 ), it is prohibited to go into or be upon any area which is closed for the protection of: threatened, endangered, rare, unique, or vanishing species of plants, animals, birds or fish;
  - b. Applicable to all caves, except for purposes of research and exploration, it is prohibited to:
    - i. [261.52(a)] build, maintain, attend, or use a campfire or stove fire; fires may be allowed in regard to traditional native ceremonies in compliance with the American Indian Religious Freedom Act and the Native American Graves Protection and Repatriation Act, their amendments and implementing regulations.
    - ii. [261.52(c)] smoke;
    - iii. [261.58(e)] camp;
    - iv. [262.52(f)] possess, discharge, or use any kind of fireworks or other pyrotechnic device;
    - v. [261.58(m)] discharge a firearm, air rifle or gas gun; or
    - vi. [261.58(s)] possess a dog or cat.
16. **Collection or Removal of Cave Resources.** The Federal Cave Resources Protection Act authorizes the Secretary of Agriculture to issue permits for the collection and removal of cave resources under such terms and conditions as the Secretary may impose, including the posting of bonds to ensure compliance with the provisions of any permit. Specific guidelines are found for the issuance of such permits in the Act.

The Act further states "any person who, without prior authorization from the Secretary, knowingly destroys, disturbs, defaces, mars, alters, removes or harms any significant cave or alters the free movement of any animal or plant life into or out of any significant cave located on Federal Lands, or enters any significant cave located on Federal lands with the intention of committing any act described in this paragraph shall be punished..." The act goes on to describe specific punishment and sets civil penalties.

- a. The Forest will comply with the Act by requiring permits for any collection of cave resources or when studies are proposed that could adversely impact cave resources. (See definition of Cave Resources in the FCRPA.)
- b. Issue permits only when it has been determined that collections or studies will not create long-term impacts to cave resources.
- c. Issue all permits with the provision that a copy of the study results is provided to the Forest Service.
- d. All permits shall require assurance from the holder that the locations of significant caves will remain confidential.
- e. Issue permits only when it has been determined that the proposed activities are consistent with the FCRPA, FSM direction, and are within Forest Plan Standards and Guidelines.
- f. Issue collection permits for scientific research and educational purposes only.
- g. No permits will be issued for removal of cave resources intended for personal collections or for purposes unlikely to generate new contributions of scientific knowledge or understanding of National Forest caves.

